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DATE: Sunday, April 04, 2004 [Printable Copy](#) [Create Case](#)

<u>Set Name</u> side by side	<u>Query</u>	<u>Hit Count</u>	<u>Set Name</u> result set
DB=PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD; PLUR=YES; OP=OR			
<u>L17</u>	l13 and L16	2	<u>L17</u>
<u>L16</u>	identif\$	1344233	<u>L16</u>
<u>L15</u>	l13 and L14	1	<u>L15</u>
<u>L14</u>	threshold	503372	<u>L14</u>
<u>L13</u>	l11 and L12	2	<u>L13</u>
<u>L12</u>	synchroniz\$	443841	<u>L12</u>
<u>L11</u>	l4 and L10	2	<u>L11</u>
<u>L10</u>	l7 and L9	2	<u>L10</u>
<u>L9</u>	second adj packet	3331	<u>L9</u>
<u>L8</u>	l1 and L7	1	<u>L8</u>
<u>L7</u>	l2 and L6	184	<u>L7</u>
<u>L6</u>	expect\$ adj frequency	2660	<u>L6</u>
<u>L5</u>	l3 and L4	5	<u>L5</u>
<u>L4</u>	monitor\$ and locat\$	453830	<u>L4</u>

<u>L3</u>	l1 and L2
<u>L2</u>	signal adj strength
<u>L1</u>	second adj packet adj data

9	<u>L3</u>
35888	<u>L2</u>
191	<u>L1</u>

END OF SEARCH HISTORY



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L17: Entry 2 of 2

File: USPT

Oct 1, 2002

DOCUMENT-IDENTIFIER: US 6459888 B1

TITLE: Method of estimating carrier frequency in a digital mobile communications system through multiple hypotheses performed on the received signal

Brief Summary Text (6):

Even though a mobile unit is camped on a base cell (often referred to as being attached to a serving cell), it must still monitor transmissions from neighboring cells. Specifically, as the mobile unit roams, it monitors signal strength from the serving cells and neighboring cells and must be able to demodulate transmissions from these cells to ensure continuous reception of transmitted information. If these cells are transmitting at frequencies that are each offset by ± 0.50 Hertz relative to the target frequency and if the local oscillator of the mobile unit is offset by ± 0.100 Hertz, the combined frequency offset could be as large as ± 0.200 Hertz. Accordingly, the mobile unit must be able to correctly demodulate signals from a variety of transmitting base stations, each of which may be transmitting at a frequency that is offset from the expected or nominal frequency.

Brief Summary Text (8):

Reception problems become more apparent as the mobile unit roams so that distance to the serving cell and the neighboring cells rapidly changes. Indeed, if the movement is at a high rate, the Doppler effect can induce a significant frequency offset that will be manifested as lost data. For example, rapidly moving toward one cell and away from a second cell, the frequency of transmitted signals from the two cells may be offset by about ± 0.500 Hertz. Doppler errors can then combine with the previously identified errors to give composite frequency errors up to ± 0.700 Hertz.

Detailed Description Text (4):

Referring to FIG. 1, a GSM communication system is shown in schematic form. The system comprises base stations, 102, 104 and 106 and a mobile unit 108. At any one time, any of base stations 102-106 could be a serving cell but for purposes of illustration base station 102 is a serving cell through which a connection to the telephone system (not shown) has been established. Stations 104 and 106 are deemed to be neighboring cells to which the connection may be transferred as mobile unit 108 roams from one cell territory to another. Mobile unit 108 is shown moving away from the serving cell (base station 102) and toward the neighboring cells as represented by arrow 110. Transmitted signal 112, as broadcast by base station 102, will have a nominal transmission frequency. However, because of the motion of mobile unit 108, the observed frequency at mobile unit 108 will be less than the broadcast frequency due to the Doppler effect. Base stations 104 and 106 also broadcast signals 114 and 116 that are received by mobile unit 108. These signals are transmitted on the synchronization channel (SCH) and are used for control purposes and in determining reference phase of the transmitted signal. These SCH signals are useful in transferring transmission to another serving cell (such as, by way of example, base station 106) as the mobile unit 108 moves outside the transmission range of base station 102.

Detailed Description Text (6):

Refer now to FIG. 2. In mobile communication systems data is transmitted in a plurality of data bursts. Each data burst 202 is about 525 microseconds in duration in a GSM system during which it is possible to transmit about 146 bits of information. In GSM systems, each data burst contains two 38-bit packets 204 with the initial packet preceded by a three-bit preamble 206. A three-bit post-amble 208 follows the second of packets 204. Packets 204 include ten (10) parity bits to facilitate detection of transmission errors through simple parity checks or CRC checks.

Detailed Description Text (15):

Separating packets 204 is a 64-bit mid-amble 210 a modulated (e.g. by phase, or by frequency) signal comprising a known bit pattern useful as a training sequence to synchronize transmission correlating the mid-amble 210 with its known bit pattern produces a peak that, when located, defines bit positions for ambles 206 and 208 and information packets 204. More specifically, in GSM systems, phase reference is established with respect to the middle of the burst so it is necessary to find the middle of the data burst 202 after it has been digitized and stored into memory. Finding the middle is determined by correlating mid-amble 210 against a known signal template to find a burst peak. One method for finding the peak of data burst 202 is described in greater detail in the co-pending United States patent application entitled IMPROVED TIMING ESTIMATION IN MOBILE COMMUNICATION SYSTEMS USING PARABOLIC INTERPOLATOR, Ser. No. 09/163640, filed on Sep. 30 1998, the disclosure of which is incorporated herein by reference.

Detailed Description Text (16):

Once the correlation is complete, the phase of the mid-amble provides the phase of the entire burst and thereby synchronizes the demodulator with the signal for recovery of the encoded bits $u(k)$. Specifically, since the SCH burst is about 525 microseconds in duration and since there are about 142 bits of information, the difference in phase angle between the beginning and the end of the burst will be:

Detailed Description Text (23):

More particularly, data burst 202 is demodulated using the hypothesis that the data burst was received without phase rotation. This hypothesis assumes that SNR curve 302 will provide adequate signal strength to recover the encoded data bits $u(k)$. The parity bits (that is, $u(25)$ to $u(34)$) obtained from the recovered data are checked to determine if any errors are present in the recovered data and a flag is set to indicate whether any non-recoverable errors were detected. This flag is stored in memory.

Detailed Description Text (24):

The data burst is then demodulated a second time but the hypothesis is that the data burst has a phase rotation of $+a$ degrees on the first burst and a phase rotation of $-a$ degrees on the next burst. As shown by SNR curve 306 to compensate for the expected frequency shift, SNR curve 306 will minimize the BER if the signal has a frequency offset at or about 500 Hertz. Accordingly, if the received signal has a positive frequency, demodulation performance will be good in the middle of SNR curve 306 but will degrade as frequency offset increases or decreases. Likewise, SNR curve 308 will minimize the BER if the signal has a frequency offset at or about -500 Hertz. The recovered data is again checked and a second flag is set to indicate whether any non-recoverable errors were detected. The second flag is also stored in memory.

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L11: Entry 2 of 2

File: USPT

Oct 1, 2002

DOCUMENT-IDENTIFIER: US 6459888 B1

TITLE: Method of estimating carrier frequency in a digital mobile communications system through multiple hypotheses performed on the received signal

Brief Summary Text (6):

Even though a mobile unit is camped on a base cell (often referred to as being attached to a serving cell), it must still monitor transmissions from neighboring cells. Specifically, as the mobile unit roams, it monitors signal strength from the serving cells and neighboring cells and must be able to demodulate transmissions from these cells to ensure continuous reception of transmitted information. If these cells are transmitting at frequencies that are each offset by ± 0.50 Hertz relative to the target frequency and if the local oscillator of the mobile unit is offset by ± 0.100 Hertz, the combined frequency offset could be as large as ± 0.200 Hertz. Accordingly, the mobile unit must be able to correctly demodulate signals from a variety of transmitting base stations, each of which may be transmitting at a frequency that is offset from the expected or nominal frequency.

Detailed Description Text (6):

Refer now to FIG. 2. In mobile communication systems data is transmitted in a plurality of data bursts. Each data burst 202 is about 525 microseconds in duration in a GSM system during which it is possible to transmit about 146 bits of information. In GSM systems, each data burst contains two 38-bit packets 204 with the initial packet preceded by a three-bit preamble 206. A three-bit postamble 208 follows the second of packets 204. Packets 204 include ten (10) parity bits to facilitate detection of transmission errors through simple parity checks or CRC checks.

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Separating packets 204 is a 64-bit mid-amble 210 a modulated (e.g. by phase, or by frequency) signal comprising a known bit pattern useful as a training sequence to synchronize transmission correlating the mid-amble 210 with its known bit pattern produces a peak that, when located, defines bit positions for ambles 206 and 208 and information packets 204. More specifically, in GSM systems, phase reference is established with respect to the middle of the burst so it is necessary to find the middle of the data burst 202 after it has been digitized and stored into memory. Finding the middle is determined by correlating mid-amble 210 against a known signal template to find a burst peak. One method for finding the peak of data burst 202 is described in greater detail in the co-pending United States patent application entitled IMPROVED TIMING ESTIMATION IN MOBILE COMMUNICATION SYSTEMS USING PARABOLIC INTERPOLATOR, Ser. No. 09/163640, filed on Sep. 30 1998, the disclosure of which is incorporated herein by reference.

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Refine Search

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L5

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DATE: Sunday, April 04, 2004 [Printable Copy](#) [Create Case](#)

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<u>L5</u>	l3 and L4	5	<u>L5</u>
<u>L4</u>	monitor\$ and locat\$	453830	<u>L4</u>
<u>L3</u>	l1 and L2	9	<u>L3</u>
<u>L2</u>	signal adj strength	35888	<u>L2</u>
<u>L1</u>	second adj packet adj data	191	<u>L1</u>

END OF SEARCH HISTORY

First Hit Fwd Refs

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L5: Entry 5 of 5

File: USPT

Dec 31, 1996

DOCUMENT-IDENTIFIER: US 5590133 A

TITLE: Apparatuses and mobile stations for providing packet data communication in digital TDMA cellular systems

Brief Summary Text (6):

Fixed wireless applications, including remote monitoring and control applications, and credit card verification and similar financial transaction applications.

Brief Summary Text (22):

This document describes (for one of the embodiments) a new packet mode cellular radio system architecture, and a new procedure for routing (voice and/or data) packets to a mobile station. Base stations, public switches via trunk interface units, and a cellular control unit are linked together via a wide area network. The routing procedure is based on mobile station initiated handover and on adding to the header of any packet transmitted from a mobile station (during a call) an identifier of the base station through which the packet passes. In case of an extended period of time between subsequent user information packets from a mobile station, the mobile station may transmit extra control packets for the sole purpose of conveying cell location information. The cellular control unit is primarily involved at call establishment, when it assigns to the call a call control number. It then notifies the mobile station of the call control number and the trunk interface unit of the call control number and the identifier of the initial base station. During a call, packets are then routed directly between the trunk interface unit and the currently serving base station.

Brief Summary Text (24):

CDPD is a new concept for providing packet data services, utilizing available radio channels on current Advanced Mobile Phone Service AMPS systems (i.e. the North American Analog Cellular System). CDPD is a comprehensive, open specification endorsed by a group of U.S. cellular operators. Items covered include external interfaces, air interfaces, services, network architecture, network management, and administration. The CDPD system specified is to a large extent based on an independent infrastructure. Common denominators with AMPS systems are limited to utilization of the same type of radio frequency channels and the same base station sites (the base station itself, used by CDPD, is new and CDPD specific), and employment of a signalling interface for coordinating channel assignments between the two systems. Routing a packet to a mobile station is based on, first routing the packet to a home network node (home Mobile Data Intermediate System, MD-IS) equipped with a home location register (HLR), based on the mobile station address; then, when necessary, routing the packet to a visited, serving MD-IS based on HLR information; and finally transferring the packet from the serving MD-IS via the current base station, based on the mobile station reporting its cell location to its serving MD-IS.

Brief Summary Text (31):

The system described in documents a) is data call oriented and based on using system initiated handover in a similar way as for regular voice calls. Applying these principles for providing general purpose packet data services in a TDMA

cellular system would imply spectrum efficiency and performance disadvantages. For example, system initiated handover in GSM is based on allocating 1/26 of a traffic channel capacity during a call for signalling related to monitoring and controlling signal quality (for a single mobile station) in preparation for a possible handover.

Brief Summary Text (41):

For example, Applicants' invention provides an apparatus for providing packet data communication to and from mobile stations in a digital TDMA cellular system having a plurality of base stations providing regular cellular control channels; one or more mobile services switching centers, each being associated with a visitor location register and being coupled to a subordinated plurality of the base stations; and home location register means for storing information on subscribers. The apparatus comprises a channel providing device for providing, in at least some of the base stations, on a per cell basis, one or more shared packet data channels for packet transfer to and from the mobile stations, and a packet transfer controlling device for controlling the packet transfer.

Brief Summary Text (43):

The apparatus further comprises a packet routing device for routing packets to and from a service area of a mobile services switching center; a first device for performing cell selection for a mobile station in packet data mode; a first device for performing location updating for the mobile station in packet data mode; a first packet data mode maintaining device for maintaining the packet data mode for a roaming mobile station; and a first packet data mode terminating device for terminating the established packet data mode for the mobile station.

Brief Summary Text (44):

Applicants' invention also provides a mobile station for packet data communication over digital TDMA cellular shared packet data channels provided by the apparatus described above. The mobile station comprises a channel identifying device for identifying, on a per cell basis, the packet data channel to be used for initiating packet transfer; a second packet data mode establishing device for establishing packet data mode for the mobile station to enable it to send and receive packets over the packet data channels; a device for sending and receiving packets over the packet data channels; a second device for performing cell selection in packet data mode; a second device for performing location updating in packet data mode; a second packet data mode maintaining device for maintaining the packet data mode for the mobile station; and a second packet data mode terminating device for terminating the established packet data mode for the mobile station.

Detailed Description Text (6):

FIG. 1 illustrates a GSM system enhanced with packet data (PD) functions, the major PD function blocks shown with bold contour lines. A plurality of Base Transceiver Stations (BTSs), each providing radio communication service to multiple Mobile Stations (MSs) in one cell, together provide complete coverage of the GSM Public Land Mobile Network (PLMN) service area. Only one BTS and one MS are shown schematically in the figure. It comprises a Mobile Termination (MT) and a Terminal Equipment (TE) part. A group of BTSs is controlled by a Base Station Controller (BSC), and these together form a Base Station System (BSS). One or more BSSs are served by a Mobile services Switching Centre (MSC) with an associated Visitor Location Register (VLR). An MSC controls calls to and from other networks such as PSTN (Public Switched Telephone Network), ISDN (Integrated Services Digital Network), or other PLMN networks. An MSC equipped for routing incoming calls is referred to as a Gateway MSC (GMSC). One or more MSC service areas together constitute the PLMN service area. Furthermore, the MSC/VLR(s) are via a CCITT (International Telegraph & Telephone Consultative Committee) Common Channel Signalling (CCS) system No. 7 network connected to a Home Location Register (HLR), which is a data base comprising information on all subscribers, including location information identifying the MSC/VLR where a subscriber is currently (or was last)

registered. Connected to HLR, is an Authentication Centre (AUC), that provides HLR with authentication parameters. To allow identification of subscriber equipment, an Equipment Identity Register (EIR) is provided, connected to the MSC(s). Finally, an Operations and Maintenance Centre (OMC) may be included for providing overall network support.

Detailed Description Text (8):

In MSC/VLR, a "PD router" is provided for routing packets to and from the MSC service area. Furthermore, a "PD controller" is provided for handling signalling exchange with the "circuit mode MSC", and for handling control, monitoring and parameter storage functions related to packet data MSs. The PD controller comprises processor, memory, signalling interface functions, and software. (Note: Although the PD router and PD controller are described as being provided in MSC/VLR, it should be understood that they, wholly or partly, physically could be realized in the form of external equipment attached to MSC.)

Detailed Description Text (15):

In PD mode, an MS performs cell selection and location updating based on GSM idle mode procedures. (Handover, in the GSM sense, is not used.) When roaming between cells, the MS, from information broadcasted on BCCH, identifies the PDCH that may be used for initiating packet transfer in a cell. Initiation of packet transfer to an MS from its currently serving MSC is guided by monitoring the MS's cell location based on any previous packet transfer. Depending on the recentness of the cell location information, and on other MS operational parameters (e.g. mobile or stationary mode of operation), the packet transfer may be initiated with or without paging.

Detailed Description Text (16):

When an MS moves to a location area belonging to a new MSC/VLR, the PD mode registration and any associated information stored at the MS's currently serving MSC/VLR is transferred from the old to the new MSC/VLR. Peer entities of any routes established to the MS's current MSC are also updated with routing information to the new MSC.

Detailed Description Text (18):

PD Mode in relation to regular GSM idle mode and call-connected mode is illustrated in FIG. 4. In this and other figures, the denomination "state" is used as a synonym for "mode". When a packet data MS is turned on, standard GSM power-on and registration procedures are used. After registration, the MS is in attached, idle mode and performs idle mode cell selection and location updating. In order to stay attached to the system, the MS also regularly initiates periodic registration.

Detailed Description Text (19):

An MS in idle mode may change to PD mode (transition (1) in FIG. 4) by a procedure based on regular GSM signalling and authentication. The procedure may be initiated either by the MS, or by the MSC, currently serving the MS, receiving a packet addressed to the MS. The procedure in the former case is exemplified by the sequence diagram in FIG. 5. Initiation of the procedure may, as determined by a system parameter, be allowed only in cells where a PDCH is allocated or is allocatable on user demand. The signalling sequence (1)-(13) in the figure is based on standard GSM signalling and authentication procedures used for setting up regular GSM voice/circuit data calls. A new type of service request (signal (3)) is used to request PD mode establishment. The optional sequence (8)-(13) is employed to allocate the MS a TMSI (Temporary Mobile Subscriber Identity) and/or to initiate packet encryption/decryption parameters in the MS and its current MSC. After successful completion of the signalling sequence (1)-(13), the MS is registered in its current MSC/VLR as being in PD mode and (optional) encryption parameters are stored (block (14)). The sequence (15)-(17), also based on regular GSM signalling, confirms the PD mode registration and makes the MS change to PD mode. If a PDCH is not already allocated in the cell in question, the PDCH allocation controller in

BSC (FIG. 1) attempts to allocate a PDCH on demand (blocks (18)-(20)). If a channel is available, BSC sends a command to BTS to activate a PDCH and to broadcast channel defining information on BCCH (block (21)). An optional channel defining signal (not shown in the figure) may also be sent directly to the MS, in order to provide a faster notification that a PDCH is allocated. At decision block (22), the MS determines if a PDCH is allocated. If this is the case, the MS may initiate a packet transfer on the defined PDCH. If no PDCH is allocated, the MS may proceed with a predefined procedure, such as periodically initiating a PDCH on demand allocation procedure (described in section I.C below). MSC/VLR is then, via the signal denoted (23), informed that the PD mode establishing procedure is completed. Signal (23) conveys information on the MS's cell location and, optionally, on whether a PDCH is allocated in the cell. This information is stored, linked to the PD mode registration (block (24)). As also indicated in block (24), if PD mode is monitored by a timer and/or inactivity timer, these timers, located in the PD controller (FIG. 1), are initiated.

Detailed Description Text (21):

VLR (as well as HLR) is enhanced with packet data subscription parameters such as IP address, multicast address, and timeout parameters. For an MS in idle mode, this information is always available in the current VLR by means of regular location updating procedures (adapted to handle the additional subscription parameters). VLR is also extended with information on whether an MS is in PD mode.

Detailed Description Text (23):

a) Storage of operational parameters related to any MS in PD mode, including encryption parameters, timers, cell location, list of peer entities of any routes established, and the MS's current submodes (e.g. mobile/stationary mode, normal/sleep paging mode; see below).

Detailed Description Text (24):

b) In order to facilitate fast packet routing and limit the interrogation load of VLR, storage also of a duplicate from VLR of all relevant information stored for any MS in PD mode (including subscription parameters and location area identity).

Detailed Description Text (27):

Location updating for an MS in PD mode is based on idle mode location updating procedures. When an MS in PD mode moves to a location area belonging to a new MSC/VLR, the new VLR automatically receives the related subscription parameters (from HLR), as part of regular idle mode location updating. The location updating procedure is enhanced such that the new MSC/VLR is informed that the MS is in PD mode, and is provided information on the backbone network address of the previous MSC/VLR. Initiated by the PD controller in the new MSC/VLR, the MS's operational parameters are then transferred (across the backbone network) from the PD controller in the previous MSC/VLR, and the data bases of the two PD controllers are updated. The PD controller in the new MSC/VLR also provides updated routing information to peer entities of any routes established to the MS's current MSC.

Detailed Description Text (29):

Returning to FIG. 4, the normal situation for an MS in PD mode is that it is located in a cell with at least one PDCH allocated. The first PDCH allocated in a cell, on which packet transfers are initiated, is here designated "Master PDCH" (MPDCH). In this normal situation, the MS performs what is here referred to as "PDCH procedures" (the upper smaller circle in FIG. 4). An MS, using "PDCH procedures":

Detailed Description Text (31):

Measures signal strength on current and surrounding cells (when not doing anything else, e.g. between PDCH slots of consecutive TDMA frames), and keeps an updated list of the 6 strongest BCCH carriers.

Detailed Description Text (35):

In an alternative realization of the embodiment, the modified cell selection criteria may be employed also for an MS in mobile mode. Provided that the information on the MS's cell location (stored in the PD controller) is sufficiently recently updated, packet transfer to the MS may be initiated in a similar way as to a "stationary" MS.

Detailed Description Text (57):

a) When the MS moves to a new location area. It then performs location updating based on idle mode procedures. Upon completion, the MS returns to "PDCH procedures" (transition (4) in the figure).

Detailed Description Text (61):

Depending on system configuration (operator's choice), the MS may be required to report to its current MSC/VLR when it moves from a cell with PDCH allocated to one without, and vice versa. This information is stored in the PD controller (FIG. 1) which thus monitors the procedures used by the MS. In this case, paging is made on either MPDCH or ordinary GSM paging channel. In a system where the PD controller does not have this information, paging has to be made in parallel on both MPDCH and ordinary GSM paging channel, if the paging area comprises cells of both kinds.

Detailed Description Text (67):

As indicated above, PD mode for an MS may be monitored by a timer and/or inactivity timer, handled by the PD controller in the MSC/VLR currently serving the MS. When PD mode is established, each timer provided is initiated to count a predetermined period of time (timeout period). The inactivity timer is reset and reinitiated for any packet received from or sent to the MS. The time out periods may be subscription parameters. Termination of PD mode and return to idle mode (transition (2) in FIG. 4) may be initiated by a termination request from the MS, or by a termination command from the PD controller when a timeout occurs.

Detailed Description Text (79):

As part of a dynamic channel allocation process, monitors traffic load on PDCH(s) and generates PDCH allocation/PDCH release requests to the PDCH allocation controller in BSC, as required.

Detailed Description Text (87):

a) When PD mode is established for an MS (located in the cell), an MPDCH is allocated (if a channel is available) as the last part of the PD mode establishment procedure as described in section I.B. The PDCH allocation is initiated by a command from the circuit mode BSC to the PDCH allocation controller.

Detailed Description Text (88):

b) When an MS in PD mode (located in the cell) has data to send, it makes a "PDCH allocation request" using "GSM procedures" as illustrated in FIG. 8. The signalling sequence (1)-(4) is based on standard GSM signalling with the addition of a new type of service request (signal (3)). The service request is received by the circuit mode BSC which, if a channel is available, generates a PDCH allocation command to the PDCH allocation controller. An MPDCH is then allocated (block (6)) and channel defining information is broadcasted on BCCH (block (7)). An optional channel defining signal (not shown in the figure) may also be sent directly to the MS, in order to provide a faster response. At decision block (8) the MS determines if a PDCH is allocated. If this is the case, it may proceed with initiating a packet transfer on the defined MPDCH. If no PDCH is allocated, the MS may proceed with a predefined procedure, such as periodically repeating the PDCH allocation request.

Detailed Description Text (89):

c) When a packet addressed to an MS in PD mode (located in the cell), is received by the MS's currently serving MSC/VLR, an MPDCH is allocated (if a channel is

available) if the following paging, using GSM paging channel, results in a positive paging response. With the addition of an initial paging, the procedure is very similar to the one described above for the mobile originated case.

Detailed Description Text (90):

d) In a situation when an MS, in PD mode and located in an adjacent cell where PDCH is allocated, has a data communication session in progress or has data ready to send immediately prior to moving into the "PDCH on demand cell", it may initiate a "PDCH allocation request" for the new cell, using the MPDCH in the currently serving cell. The request is transferred to the PD controller in MSC/VLR, from which it is forwarded to the PDCH allocation controller in BSC, and from there to the circuit mode BSC. If the request is granted, the MS may not need to change to "GSM procedures".

Detailed Description Text (98):

If no, the monitoring process proceeds.

Detailed Description Text (102):

If the lower limit is reached (at block (3)), BTS sends an MPDCH release request to BSC. After notifying MSs by means of broadcast information (block (10)), an MPDCH is released (blocks (11) and (12)). If, as in this example, it is found (at block (13)) that this was the only MPDCH, the process proceeds at point (A) with monitoring any request or command for a new MPDCH allocation.

Detailed Description Text (108):

BTS normally responds with a channel reservation command (signal (2)) on the MPDCH downlink, reserving channel capacity for uplink data transfer and down link acknowledgement (ACK). (In case of no response from BTS, the MS makes a retry after a random backoff time.) The channel reservation command includes the same random number as received in the access burst, and timing alignment/power control (TA/PC) commands. The timing alignment/power control functions are performed in BTS, not only the measurements part (as in ordinary GSM) but also, for performance reasons, the processing and command generation parts (located in the PD transfer controller).

Detailed Description Text (109):

The data frame (signal (3) in the figure) from the MS is followed by a positive acknowledgement (signal (4)) from BTS (as no retransmissions are assumed in this example), and the frame is relayed to the PD router in MSC/VLR. Here, the MS's cell location is determined by associating the frame (which includes the MS's identity TMSI in the frame header) with the (for each cell unique) physical connection on which the frame is received. In an alternative realization, the MS's cell location may be identified by providing in the PD transfer controller in BTS the additional function of inserting a cell identifier in the frame header, in a similar way as described in the cited U.S. Pat. No. 4,916,691. The cell location identity and the associated time when the frame was received are, together with MS parameters (such as mobile/stationary indicator, class of service) that may be conveyed in the frame header from BTS, stored in the PD controller data base, linked to the MS's identity. The packet, normally after decryption, is then available at the layer 3 entity of the PD router for routing to the destination (in the example in FIG. 10 via an IWF).

Detailed Description Text (111):

Cell location and recentness of the information

Detailed Description Text (117):

This method is used if the MS is in stationary mode. It may be used also when the MS is in mobile mode, provided that the modified cell selection criteria employed in stationary mode (described in section I .B) is employed also for MSs in mobile mode, and provided that the cell location information is sufficiently recently

updated.

Detailed Description Text (121):

To economize on spectrum, paging is limited to the smallest possible group of cells based on available cell location information. Paging is initiated by a "high level command" (including information on IMSI, TMSI, location area, cell location and recentness of this information, and paging mode) from the PD controller to the PD signalling controller (FIG. 1) in affected BSC(s). (Alternative divisions of paging functions between MSC and BSC are not precluded.) As described in section I.B, depending on system configuration, the paging may include paging on both MPDCH and ordinary GSM paging channel and may thus involve also the "circuit mode" portion of BSC(s).

Detailed Description Text (122):

In a situation when the probable cell location can be limited to a small group of cells, a special type of paging message may be employed which combines paging with reservation of an access slot for the MS to respond. An example of using this type of paging is shown in the sequence diagram in FIG. 12. With the signal marked (5) in the figure, the paging command initiated by MSC reaches BTS. The PD transfer controller in BTS then generates a paging message (signal (7)) on the MPDCH downlink which includes reservation of an access slot on the MPDCH uplink for the MS to send a response burst (signal (8)). The paging response (signal (9) and (12)) transferred back to MSC includes information on the MS's cell location, which information (with the associated time when the paging response was received) is stored in the PD controller data base. The paging response also results in a channel reservation (signal 10)) on the MPDCH downlink for the data transfer. The channel reservation also includes TA/PC commands. When data is received from MSC (signal (13)), it is transferred on the reserved PDCH downlink (signal (16)). Channel reservation for an acknowledgement from the MS (signal (17)) and for possible retransmission may either be combined with the data frame (signal (16)) or included in the initial channel reservation (signal (10)).

Detailed Description Text (125):

As minimization of the total usage of radio channel resources for location updating/cell location reporting on one hand, and paging on the other, is crucial for spectrum efficiency, some complementary mechanisms may be needed for MSs in PD mode. These may include the use of smaller location areas than in regular GSM and/or, under certain conditions, cell location reporting from MSs.

Detailed Description Text (137):

When the MS moves to a location area belonging to a new MSC/VLR, transferring the list of peer entities (and other parameters related to the MS) from the old to the new MSC/VLR; and updating the peer entities with routing information to the new MSC.

Detailed Description Text (139):

Furthermore, each route may be monitored by an inactivity timer, handled by the PD controller in the MSC/VLR currently serving the MS. When the route is established, the inactivity timer is initiated to count a predetermined period of time (timeout period). The inactivity timer is reset and reinitiated for any packet received from the route, addressed to the MS. The timer is reset and reinitiated also for any packet from the MS to the route, when the route is a bidirectional route between the MS's current MSC and another MS's current MSC, linked to the two MSs' respective PD mode registrations. The timeout period may be a subscription parameter. When a timeout occurs, the peer entity is informed and the route is terminated.

Detailed Description Text (150):

If yes: If the route is monitored by an inactivity timer, the timer is reset and reinitiated. The sequence then proceeds with transferring the packet to the MS (as

described in section I.D).

Detailed Description Text (151):

If no: The IP address of IWF 1 is stored (linked to MS 1's identity), indicating that a route is being established. If the route is to be monitored by an inactivity timer, the timer is initiated. The sequence then proceeds with 9).

Detailed Description Text (157):

If yes: If the route is monitored by an inactivity timer, the timer is reset and reinitiated. The packet is then either transferred to MS 2, if MS 2 is registered in the same MSC (MSC 1), or routed to MSC 2's current MSC using the encapsulation technique described above.

Detailed Description Text (160):

If yes: The packet is either transferred to MS 2, if MS 2 is registered in the same MSC (MSC 1), or routed to MS 2's current MSC using the encapsulation technique described above. MS 2's current MSC then initiates establishment of a (bidirectional) route between the two MSs' current MSCs, linked to their respective PD mode registrations. If the route is to be monitored by inactivity timer(s) (at one or both ends of the route), the timer(s) are initiated.

Detailed Description Text (182):

Thus, with the second addressing scheme, all packets to an MS, originating from entities outside the MS's current MSC service area, are routed via the MS's "predetermined MSC". It may therefore be advantageous to (optionally) initiate establishment of a route from the "predetermined MSC" to the MS's current MSC also when the PD router (in the MS's current MSC) receives a packet from the MS. Then, if it is found that the packet is not addressed to an MS located within the MSC service area, and that the mentioned route is not already established, the PD controller may initiate route establishment by:

Detailed Description Text (208):

Performs location updating in PD mode based on regular GSM procedures.

Detailed Description Text (215):

In this embodiment, the only radio channels available for MSs are PDCHs and regular GSM broadcast channels. Registration, location updating (or cell location reporting), authentication and similar signalling are thus performed via PDCHs. Furthermore, allocation of the first MPDCH on user demand, using ordinary GSM signalling as in Embodiment 1, is thus not possible. With this exception, the functions for providing PDCHs are the same as described for Embodiment 1. The first MPDCH in a cell is normally allocated by system configuration, although the method (outlined for Embodiment 1) of using a PDCH of an adjacent cell for requesting allocation of an MPDCH in a "PDCH on demand cell", prior to moving into that cell, is theoretically feasible. In that case, the allocation request would be transferred to a system entity in the MPDI. This system entity would then send an allocation request to the BTS of the "PDCH on demand cell" in question which, in its turn, would convey the request to the PDCH allocation controller in BSC.

CLAIMS:

1. An apparatus for providing packet data communication to and from mobile stations in a digital TDMA cellular system having a plurality of base stations providing regular cellular control channels and regular cellular dedicated traffic channels; one or more mobile services switching centers, each being associated with a visitor location register and being coupled to a subordinated plurality of the base stations; and home location register means for storing information on mobile station subscribers, the apparatus comprising:

channel providing means for providing, in at least some of the base stations, on a

per cell basis, one or more shared packet data channels for packet transfer to and from the mobile stations, and packet transfer controlling means for controlling the packet transfer;

channel defining means for defining, on a per cell basis, the packet data channel to be used for packet transfer;

first packet data mode establishing means for establishing packet data mode for a mobile station to enable the mobile station to send and receive packets over the packet data channels;

first packet transferring means for transferring packets between the mobile stations and base stations;

second packet transferring means for transferring packets between the base stations and their respective superior mobile services switching centers;

packet routing means for routing packets to and from a service area of a mobile services switching center;

first means for performing cell selection for a mobile station in packet data mode;

first means for performing location updating for the mobile station in packet data mode;

first packet data mode maintaining means for maintaining the packet data mode for a roaming mobile station; and

first packet data mode terminating means for terminating the established packet data mode for the mobile station.

7. The apparatus of claim 1, wherein the first means for performing location updating is adapted to perform location updating based on regular cellular idle mode procedures.

8. The apparatus of claim 1, wherein the first packet data mode establishing means comprises:

means for initiating the establishment of packet data mode for a mobile station from an initial cellular idle mode, either by the mobile station generating a packet data service request based on regular cellular control channel signalling, or by the mobile services switching center currently serving the mobile station receiving a packet addressed to the mobile station and paging the mobile station based on regular cellular control channel signalling;

means for performing a regular cellular authentication procedure after packet data mode establishment has been initiated;

means for initiating parameters for packet encryption/decryption between the mobile station and the mobile services switching center currently serving the mobile station; and

means for registering the mobile station at its current mobile services switching center with associated visitor location register as being in packet data mode.

13. The apparatus of claim 1, wherein the first and second packet transferring means, for initiating a packet transfer to a mobile station in packet data mode, comprise paging means and monitoring means for monitoring a cell location of the mobile station based on a previous packet transfer, and the first and second packet

transferring means are adapted for paging guided by the monitoring means to initiate a packet transfer to a mobile station.

14. The apparatus of claim 13, wherein the monitoring means comprises:

means for identifying a cell location of a mobile station originating a packet by, when the packet is received at the mobile services switching center currently serving the mobile station, associating the packet with the identity of a connection on which the packet is received, the connection being unique for each cell;

means for identifying a cell location of a mobile station responding to a paging message; and

means for storing for a mobile station, linked to the mobile station's packet mode registration, at least a latest cell location identified and an associated time when the cell location was identified.

15. The apparatus of claim 13, wherein the first and second packet transferring means, for initiating a packet transfer to a mobile station, further comprise means for monitoring a mobile/stationary mode indicator sent by a mobile station capable of operating in a stationary mode to its currently serving mobile services switching center at least every time the mobile station changes from mobile mode to stationary mode and vice versa.

17. The apparatus of claim 15, wherein the first and second packet transferring means are adapted to initiate packet transfers to a mobile station that is in mobile mode and performs cell selection based on regular cellular idle mode procedures without previous paging or with paging in a single cell, provided that cell location information from the monitoring means meets predefined accuracy criteria.

21. The apparatus of claim 1, wherein the packet routing means comprises:

one or more interworking function means for internetworking with at least one external network;

interconnection means for interconnecting the interworking function means and mobile services switching centers; and

means for routing packets, addressed to a mobile station, from any of the interworking function means to a mobile services switching center currently serving the mobile station, the means for routing packets including:

at the interworking function means, means for determining from stored routing information whether a route to the mobile station's currently serving mobile services switching center is established, linked to an identity of the mobile station; means for routing packets to the currently serving mobile services switching center when a route is established; and means, when a route is not established, for initially interrogating the home location register means to determine the identity of the mobile services switching center currently serving the mobile station, and for storing, linked to the identity of the mobile station, the identity of the currently serving mobile services switching center; and

at the currently serving mobile services switching center, means for initiating establishment of packet data mode for the mobile station when packet data mode is not already established, and means for initially determining and storing, linked to a packet data mode registration of the mobile station, an identity of the interworking function means.

22. The apparatus of claim 21, wherein the packet routing means, for maintaining routes established to a mobile station's currently serving mobile services switching center when the mobile station moves to a location area belonging to a new mobile services switching center, comprises means for updating at least one of interworking function means and mobile services switching centers of any routes established about the change from the currently serving mobile services switching center to the new mobile services switching center, initiated from the new mobile services switching center, based on information provided by the first packet data mode maintaining means.

23. The apparatus of claim 21, wherein the packet routing means comprises:

at the mobile station's currently serving mobile services switching center, means for monitoring, as to traffic activity, a route established to the currently serving mobile services switching center, linked to the packet data mode registration of the mobile station, and means for initiating termination of the route when the traffic activity falls below a predetermined level; and

at at least one of an interworking function means and a mobile services switching center of the route, means for cancelling related routing information when termination of the route is initiated.

24. The apparatus of claim 1, wherein the packet routing means comprises:

interconnection means for interconnecting mobile services switching centers; and

means for routing packets originated from a first mobile station and addressed to a second mobile station, including:

at the mobile services switching center currently serving the first mobile station, means for determining from stored routing information whether a route to the mobile services switching center currently serving the second mobile station is established, linked to a packet data mode registration of the first mobile station; means for routing packets to the second mobile station's currently serving mobile services switching center when a route is established; and means for initially interrogating the home location register means to determine an identity of the mobile services switching center currently serving the second mobile station when a route is not established, and for storing, as routing information, the identity of the second mobile station's currently serving switching center with the identity of the second mobile station, linked to the packet data mode registration of the first mobile station; and

at the mobile services switching center currently serving the second mobile station, means for initiating establishment of packet data mode for the second mobile station when packet data mode is not already established, and means for initially determining and storing, linked to the packet data mode registration of the second mobile station, an identity of the first mobile station and an identity of the mobile services switching center currently serving the first mobile station.

25. The apparatus of claim 1, wherein the packet routing means comprises:

interconnection means for interconnecting mobile services switching centers, and for connecting one or more mobile services switching centers to at least one external network;

means for routing packets addressed to a mobile station from an external network or another mobile station to an addressed mobile services switching center to which the mobile station belongs for packets addressed to the mobile station; and

means for routing packets addressed to a mobile station from the addressed mobile services switching center to a mobile services switching center currently serving the mobile station, including:

at the addressed mobile services switching center, means for determining from stored routing information whether a route to the mobile station's currently serving mobile services switching center is established, linked to an identity of the mobile station; means for routing packets to the currently serving mobile services switching center when a route is established; and means for initially interrogating the home location register means, when a route is not established, to determine an identity of the currently serving mobile services switching center, and for storing, as routing information, the identity of the currently serving mobile services switching center linked to the identity of the mobile station; and

at the currently serving mobile services switching center, means for initiating establishment of packet data mode for the mobile station when packet data mode is not already established, and means for initially determining and storing, linked to the packet data mode registration of the mobile station, an identity of the addressed mobile services switching center.

26. The apparatus of claim 1, wherein the first packet data mode maintaining means, for maintaining packet data mode for a mobile station when the mobile station moves to a location area belonging to a new mobile services switching center, comprises means for transferring a packet data mode registration and associated information, stored at the mobile station's currently serving mobile services switching center, from the currently serving mobile services switching center to the new mobile services switching center, initiated from the new mobile services switching center, based on information provided by the means for performing location updating.

27. The apparatus of claim 1, wherein the first packet data mode terminating means comprises means for monitoring a mobile station as to traffic activity, and means for terminating packet data mode and a route established to the mobile station's currently serving mobile services switching center when the traffic activity falls below a predetermined level.

28. The apparatus of claim 1, wherein the first packet data mode terminating means comprises means for monitoring a time elapsed since packet data mode was established for a mobile station, and means for terminating packet data mode and an associated route established to the mobile station's currently serving mobile service's switching center when the time elapsed exceeds a predetermined period of time.

29. A mobile station for packet data communication over digital TDMA cellular shared packet data channels provided by the apparatus according to claim 1, comprising:

channel identifying means for identifying, on a per cell basis, the packet data channel to be used for initiating packet transfer;

second packet data mode establishing means for establishing packet data mode for the mobile station to enable the mobile station to send and receive packets over the packet data channels;

means for sending and receiving packets over the packet data channels;

second means for performing cell selection in packet data mode;

second means for performing location updating in packet data mode;

second packet data mode maintaining means for maintaining the packet data mode for

the mobile station; and

second packet data mode terminating means for terminating the established packet data mode for the mobile station.

35. The mobile station of claim 29, wherein the second means for performing location updating is adapted to perform location updating based on regular cellular idle mode procedures.

36. The mobile station of claim 29, wherein the second packet data mode establishing means comprises:

means for initiating establishment of packet data mode in the mobile station, from an initial cellular idle mode, by one of the mobile station's generating a packet data service request based on regular cellular control channel signalling, or the mobile stations receiving a paging message based on regular cellular control channel signalling, indicating that a packet, addressed to the mobile station, has been received by a mobile services switching center currently serving the mobile station;

means for performing a regular cellular authentication procedure after packet data mode establishment has been initiated;

means for initiating parameters for packet encryption/decryption in the mobile station; and

means for storing, for the mobile station, information indicating that packet data mode is established.

37. The mobile station of claim 29, further comprising means, when the mobile station is in packet data mode and is located in a cell providing a packet data channel on user demand, for generating a packet data channel allocation request based on regular cellular control channel signalling.

38. The mobile station of claim 29, further comprising means, when the mobile station is in packet data mode and is located in a currently serving cell with a packet data channel allocated, for generating a packet data channel allocation request for an adjacent cell providing packet data channel on user demand, prior to moving into the adjacent cell, using a packet data channel of the currently serving cell.

42. The mobile station of claim 29, wherein the second packet data mode maintaining means comprises means for allowing the mobile station to make and receive regular cellular calls when being in packet data mode;

means for maintaining packet data mode as pending during a regular cellular call; and

means for returning the mobile station to active packet data mode when the regular cellular call is completed.

43. An apparatus for providing packet data communication to and from mobile stations, utilizing a plurality of base stations of a digital TDMA cellular system that provide regular cellular control channels and regular cellular dedicated traffic channels, comprising:

channel providing means for providing, in at least some of the base stations, one or more shared packet data channels for packet transfer to and from the mobile stations, and packet transfer controlling means for controlling the packet transfer;

channel defining means for defining, on a per cell basis, the packet data channel to be used for packet transfer;

packet transferring means for transferring packets between mobile stations and base stations;

coupling means for coupling the packet transfer controlling means to a separate mobile packet data infrastructure comprising packet routing means, for routing packets to and from a service area of a mobile switching center, and mobility management means, for managing location and routing information for the mobile stations; and

first means for performing cell selection for the mobile stations.